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Qualitative and Quantitative Evidence on the True Local Welfare Costs of Forest Conservation in Madagascar: Are Discrete Choice Experiments a Valid *ex ante* Tool?

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Summary. — Protected areas may impose local welfare costs through the enforcement of use restrictions. Predicting their welfare impacts before their establishment could help with the design of compensation schemes. Discrete choice experiments (DCEs) are increasingly used for *ex ante* evaluations but their validity is largely untested in low-income settings. Using a case study of a new REDD+ (Reducing Emissions from Deforestation and forest Degradation) project in eastern Madagascar, we explore the validity of DCEs in two ways: (i) whether the estimates of welfare costs derived from DCE are affected by respondents' prior experience of conservation (ii) whether DCE results have high theoretical and content validity. We surveyed households who have varying degrees of experience of restrictions to swidden agriculture. We also qualitatively debriefed a sub-sample of respondents to better understand their thought processes. Latent class analysis shows that DCE outcomes vary with conservation experience. Households more experienced with forest protection are less willing to trade-off rights to clear forest for swidden agriculture with any compensatory interventions whereas less experienced households highly favor support for alternative agricultural techniques and a secure right to clear one hectare of forest. Although the results show apparent non-attendance to some attributes (e.g., cash payments), qualitative debriefings suggest that respondents infact do expect relatively low or no utility from the given attributes and hence have theoretically valid preferences. Similarly, the DCE has generally high content validity. Although DCE can elicit current preferences in this context, using *ex ante* DCE to estimate the welfare costs of such a long-term intervention requires caution. We conclude that it is difficult to robustly estimate compensation in advance of an intervention, there is therefore a need to rethink conservation approaches, and the feasibility of achieving fair compensations for conservation-imposed restrictions.

Key words — welfare impacts, compensations, REDD+, choice experiment, validity, Madagascar

1. INTRODUCTION

Conserving biodiversity through the establishment of protected areas (PAs) has been the foundation of conservation in the tropics. The number and extent of PAs have increased rapidly in the last decades (Jenkins & Joppa, 2009), particularly in least developed countries where they are viewed as an urgent response to the increasing loss of biodiversity. Although there is a wide range of PA categories, most involve some degree of restrictions on access to natural resources which may have negative impacts for the welfare of local communities dependent on those resources. REDD+ (Reducing Emissions from Deforestation and Forest Degradation) is resulting in a further increase in tropical forest areas where access restrictions are imposed on local resource users (Ghazoul, Butler, Mateo-Vega, & Koh, 2010).

Despite decades of recognition of these local costs, compensation measures are often delayed, incomplete, or non-existent (e.g., Cernea & Schmidt-Soltau, 2006). Attempts to provide compensation started with integrated conservation and development projects (ICDPs) in the 1980s, which promoted rural development projects but which generally failed to achieve development on a scale commensurate with the costs (Brandon & Wells, 1992). Community-based natural resource management (CBNRM) and related concepts have been pursued to enable communities to participate in the management of natural resources and benefit from these resources (Brosius, Tsing, & Zerner, 1998). Although there are successful cases, CBNRM has often not been able to compensate for the

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opportunity costs of protection (e.g., Berkes, 2004). More recently, Payments for Ecosystem Services (PES) schemes emerged, with an aim to internalize the benefits that people obtain from ecosystems using market or quasi-market exchanges (Grieg-Gran, Porras, & Wunder, 2005). However, emerging evidence suggests that this is not providing a better outcome for local people and that compliance is mostly obtained by coercion (e.g., Milne, 2012). The REDD+ concept, which can be seen as a carbon-focused PES scheme, could be a means to finance the establishment of a new wave of PAs (Harvey, Dickson, & Kormos, 2010). However, the effectiveness of REDD+ social safeguards in adequately compensating local people has also been questioned (Chhatre & Agrawal, 2009).

The perceived urgency of conservation may have resulted in the dearth of *ex ante* assessment [1] and lack of consideration of alternative policy options, and the inclusion of the views of the affected population. All of these may have contributed to compensation failures. In this context, predicting the welfare impacts of PAs before their establishment could provide valuable evidence to improve compensation. However, a major constraint is finding robust methods to estimate welfare impacts in advance. Discrete Choice Experiments (DCEs), a stated preference valuation technique [2] (Freeman, 2003), can offer one approach to estimating welfare impacts *ex ante* through the construction of hypothetical scenarios (e.g., Cranford & Mourato, 2014). While DCEs may be prone to hypothetical bias (Hensher, 2010a), they may help decision makers predict how respondents would adapt to a policy change and devise compensation mechanisms that would integrate the affected population's needs. Besides, by inferring policy impacts from the trade-offs that respondents make, DCEs avoid asking direct questions about the policy being valued and therefore may be useful when valuing sensitive goods, such as illegal activities (e.g., Moro *et al.*, 2013; Nielsen, Jacobsen, & Thorsen, 2014). We conducted a DCE survey with rural households in eastern Madagascar affected by forest conservation to investigate the trade-offs local people would make between the right to clear new forests for swidden agriculture, cash payment compensation, and support for improved rice farming.

Although DCE methods are increasingly used in environmental valuation, their validity, especially in low-income rural settings, is largely untested (Rakotonarivo, Schaafsma, & Hockley, 2016; Whittington, 2010). First, this paper uses a natural experiment to assess the validity of *ex ante* DCE, conceptualized as the degree to which the method is measuring what the researcher intends it to measure (Bateman *et al.*, 2002). If researchers' aim is to measure the welfare impacts of forest conservation to inform the design of compensation policies, validity therefore concerns how well the DCE method, as an *ex ante* impact assessment tool, can achieve this. [3] How well *ex ante* assessment can predict the impacts of conservation may depend on the effect of respondents' prior experience with the policy. If DCE outcomes are affected by experience of forest conservation, this suggests that DCE conducted only with respondents who are yet to experience conservation may not be suitable for predicting welfare impacts and required compensations. [4] Complex and long-lasting interventions such as forest conservation may have long-lasting effects on household wellbeing which are hard for a respondent to estimate in advance.

Second, this paper aims to examine the theoretical and content validity of our DCE results by assessing how well they conform to the assumptions of the method. The first assumption relates to the continuity axiom of rational choice theory which postulates that DCE respondents need to attend to all attribute levels across each of the alternatives and make "compensatory" trade-offs (Campbell, Hensher, & Scarpa, 2011; Campbell, Hutchinson, & Scarpa, 2008). However, it may be difficult to distinguish genuine attribute non-attendance (that is ignorance of an attribute because of an incomprehensible survey design or other concerns not captured or raised by the DCE survey) from no (or low) preference for given attributes (i.e., low attribute importance) (Hess, Stathopoulos, Campbell, O'Neill, & Caussade, 2013). The former is a violation of the continuity axiom, the latter is not. What is observed in DCE results, e.g., apparent patterns of non-attendance to some attributes, may not always reveal respondents' thought processes, and qualitative debriefings that directly examine decision processes, i.e., how people make decisions, can help disentangle such issues (Arana & Leon, 2009; Powe, Garrod, & McMahon, 2005). Here, we test the extent to which our results conform to the continuity axiom by exploring the processes through which respondents arrive at their choice decisions using qualitative debriefing interviews with a subsample of respondents.

Another assumption of the DCE method pertains to the content validity of DCE, i.e., whether the survey descriptions and questions are "clear, plausible, and unbiased" so that respondents are motivated to reveal their true preferences (Bateman *et al.*, 2002). If respondents protest some features of the survey scenario, they may not have the incentives to accurately state their true welfare costs (e.g., Meyerhoff & Liebe, 2009). If respondents for instance distrust or misperceive the payment vehicle i.e., the means through which the policy outcome is delivered (Morrison, Blamey, & Bennett, 2000), or they do not believe that their responses could potentially influence policy (Vossler & Watson, 2013), their choice decisions may not be valid indications of their preferences. In our qualitative debriefing interviews we examined the extent to which a perceived lack of plausibility of the payment vehicle or consequentiality of the DCE survey may bias the results.

This is the only DCE study we know of that investigates the validity of DCE results in a low-income setting by explicitly looking at the effect on people's choices of varying exposure to a complex and long-term intervention (in this case restrictions on land use). We also believe it is the only study in a low-income context to enrich a DCE survey with rigorous qualitative data collection approaches which can significantly help to understand the psychological processes leading to respondents' answers. These additions to established economic valuation techniques for use in a low-income setting have broad applicability for environment and development researchers. However the paper also has significant implications for conservation policies and the design of compensation measures around protected areas including PES and REDD+ projects.

2. METHODS

(a) *Case study and sampling procedure*

Madagascar's protected area network has been recently expanded from 3.1% of Madagascar terrestrial surface area (1.8 million hectares) in 2003 to 10% in 2012 and now covers most of the remaining natural habitat. The local swidden agricultural system known as *tavy* (De Wilde, Buisson, Ratovoson, Randrianaivo, Carrière, & Ii, 2012) has been regarded as the main driver of deforestation in eastern Madagascar. At low population densities *tavy* may be sustainable,

but population growth has put this practice in opposition to conservation objectives (Scales, 2014). Clearance of primary forest in the *tavy* system is known specifically as *teviala* and is the main focus of conservation goals and policies.

Teviala has been criminalized in Madagascar since colonial times, however enforcement has often been weak (Kull, 2004). With the support of international donors, the state is currently making a renewed attempt to outlaw *teviala* and coercively enforce the ban. *De facto*, many forestlands are not subject to well-defined formal property right regimes, though local systems of customary tenure frequently mix with, and evolve in response to, formal state laws (Muttenzer, 2010).

To investigate the effect of experience of forest conservation on local preferences, we purposefully selected two sites Ampahitra (APT) and Mantadia (MTD) in the eastern rainforests of Madagascar which differed in their exposure to forest protection but were otherwise similar in terms of forest characteristics (i.e., situated in the same ecological zone with similar topographic and altitudinal characteristics), market access and infrastructure. The first site, the *fokontany*[5] of APT, is part of a new protected area set up in Madagascar following the country's commitment to triple its protected areas and where people have only been exposed to conservation restrictions for a relatively short period (5 years). APT is part of the corridor Ankeniheny–Zahamena ("CAZ") protected area and co-managed by Conservation International and community associations. The other site, MTD with two *fokontany* (Volove and Vohibazaha) has a long history of strict conservation and is part of the Andasibe-Mantadia protected area established 20 years ago and managed by Madagascar National Parks. The dominant and indigenous ethnicity in these two study sites (Figure 1) are *Betsimisaraka*.

There is poor information available on the location and size of communities in much of rural Madagascar making it difficult to develop a rigorous sampling frame. Since no map or census of households was available, we constructed the sampling frame in three steps: (i) key-informant interviews with *fokontany* authorities to develop a sketch-map of villages, (ii) key-informant interviews in villages to collect information on households and hamlets, (iii) visits to hamlets in person to cross check information and record GPS locations ensuring that no isolated household was missed out. Building the sampling frame took approximately 50 person-days in each site and approximately 1/3 of the total field work time. In each site we identified villages that were close to the forest and therefore affected by conservation.

We identified in total 417 households residing across the eight villages within the *fokontany* of APT and 241 households across the five villages within the *fokontany* of Volove and Vohibazaha in MTD. With the aim of interviewing a minimum of 100 households at least in each site, we randomly sampled at 65% allowing for replacement from each village (proportional random sampling). We surveyed 203[6] households in total in APT and 104 in MTD, with roughly 50% of the households surveyed from each sample.

(b) *Choice experiment design*

The attributes and levels (Table 1) were informed by three focus group discussions and pilot testing of the design with 50 respondents in nearby *fokontany* (See Appendix A for an excerpt of the background scenario, and Appendix C for the DCE experimental design).

(c) *Data collection*

The DCE survey was piloted in three phases between February and June 2014 in villages near the sampled villages. The actual survey was carried out from July to October 2014. The questionnaire was administered by OSR, RM, and three enumerators who all held at least a bachelor's degree in agricultural sciences from the University of Antananarivo. Enumerators received two weeks of training from OSR on the theoretical underpinnings of the DCE method, ethical considerations, and how to conduct the survey. Field activities were also closely supervised by NH who speaks fluent Malagasy and has more than five years' experience of similar field work. Our unit of analysis is the household and interviews were conducted with the household head, his spouse, and other household members.

The questionnaire comprised three sections: (1) Socio-economic characteristics of the household including education, household characteristics, land holdings, other household assets, and wealth indicators (such as food security), (2)

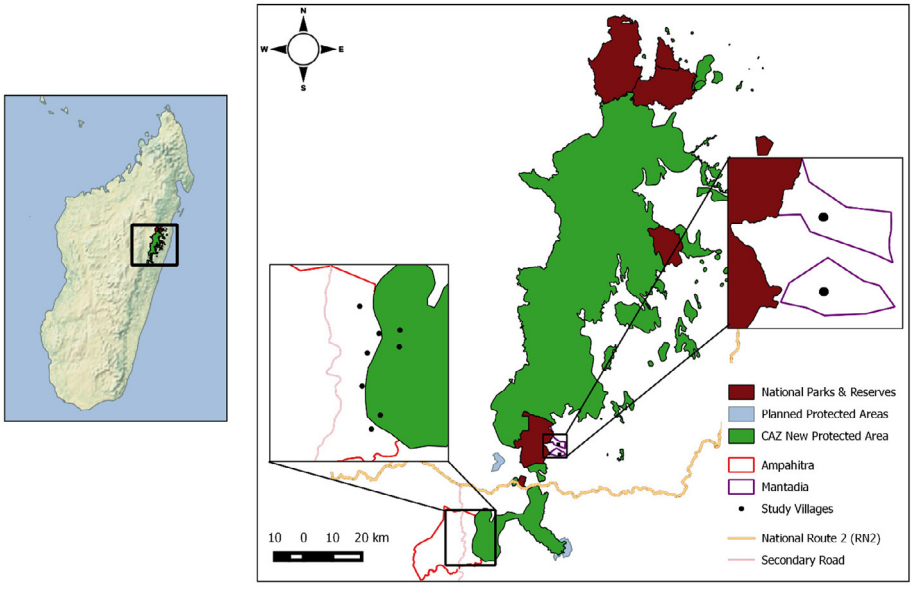


Figure 1. *Study sites: Ampahitra (CAZ New Protected Area) and Mantadia (National Park).*

Table 1. *Attributes and levels of the DCE (reference levels in bold)*

Attributes	Description	Levels	Coding and Notation	Hypotheses (Expected sign of coefficients with WTA estimates in brackets)
Total cash donations framed as development assistance (3,080 MGA = 1 USD)	The cash donations were framed as development assistance that the household would receive. Review of secondary data and previous literature estimating the local costs of deforestation aided the selection of the payment levels (e.g., Ferraro, 2002; Shyamsundar & Kramer, 1996). These were then further informed by focus groups and pilot testing.	**0**, 3, 6, 9, 12, 15 ($\times 10^6$ MGA)	Cash (continuous variable)	More cash increases the average respondents' utility (+)
Number of annual installments over which the household will receive the total payments	The three levels of installments allow an estimation of the respondents' discount rates and provide information on the respondents' ability to invest money	**1**, 10, 20	Dummy-coded: Installment10 and installment20	Higher number of installments is expected to decrease the average respondents' utility (−) (due to discounting)
Support for improved rice farming	This attribute is introduced as a sustainable and modern agricultural package that includes productivity enhancing practices such as the use of fertilizers, insecticides and/or herbicides. It involves digging and possibly the construction of terraces for slopes and precludes the use of fire as a way to maintain fertility while not fallowing the land. It also includes material support (e.g., improved seeds, wheelbarrow, spades, etc.).	**No**, yes	Dummy-coded: Support for improved rice farming coded as 1	Improved agricultural practice may increase the average respondents' utility (+)
Teviala (clearance of new forestlands for agriculture)	This attribute has three levels: i) no *teviala* (i.e., strict enforcement of restrictions), ii) a permit for one hectare of *teviala* (a one-off opportunity), iii) free *teviala* (similar to pre-colonial times before criminalization of *teviala*, and *de facto* to more recent periods of little or no enforcement).	**Free *teviala*** (open forest frontier), 1 ha of *teviala* permit and no *teviala* (strict protection),	Dummy-coded: *teviala* 1 ha, no *teviala*	Restrictions on *teviala* are expected to decrease the average respondents' utility (-)

DCE survey. (3) Follow-up questions which examined five aspects of the valuation exercise, four were measured on a five-point Likert scale while the last one is a binary question (i) Plausibility of the survey scenario, particularly the payment vehicle, (ii) Trust in the institution that is to deliver the cash donations, (iii) Consequentiality of the valuation exercise (i.e., how much respondents believe the results would be used to inform policy), (iv) Perceptions of the support for improved rice farming, and (v) Perceptions of the benefits of forest protection. OSR also conducted debriefing interviews the following day with a sub-sample selected to represent the full range of DCE responses ($N = 25$ from 206 respondents) to examine their decision-making processes. The number of interviewees was determined by data saturation.

We explained the DCE survey to respondents using dolls and large pictures (Appendix B) which helped respondents engage with the survey and framed it as a game to desensitize the illegal nature of *teviala* (an approach used by Nielsen *et al.* (2014) when valuing illegal bushmeat hunting in Tanzania). The full survey took one to two hours per household with some warm-up steps to give respondents some practice and ensure they understood the task of making trade-offs in a DCE survey. Our study protocol was reviewed and approved by the Bangor University's Ethics Review Committee.

(d) *Data analysis*

(i) *Analysis of DCE results*

Since respondents may have heterogeneous preferences, we estimated a latent class model (LCM) using the pooled dataset to identify the sources of heterogeneity and segments of respondents with similar preferences (see Appendix D) (Boxall and Adamowicz, 2002). Choosing the number of classes for the LCM involves a trade-off between model simplicity and explanatory power, and should be informed by the significance of parameter estimates, analyst judgment regarding the interpretability of the model results, the Akaike and the Bayesian Information Criteria (AIC and BIC respectively) (Scarpa & Thiene, 2005). Based on these criteria (see Appendix G[7]), we selected a 4-class model.

The utility function of an individual n facing a choice between two experimentally created alternatives and a reference level alternative can be described as:

$$\begin{cases} V(ASC, X_{ni}, \beta_k) + \varepsilon_{ni} & \text{if } i = \text{reference level alternative, otherwise,} \\ V(X_{ni}, \beta_k) + \varepsilon_{ni} \end{cases} \tag{1}$$

where U_{ni} is the utility function for individual n, for alternative i. V is the observed indirect utility, which is a function of X_{ni}, a vector of observable attributes and associated fixed parameters β_k. We specify an alternative specific constant (ASC) for the reference level, and a Gumbel distributed error term ε_{ni} as a means of capturing the unobservable factors beyond attributes present in the choice sets. We specify the utility function (U_{ni}) of an individual n of the alternative i as:

$$\begin{aligned} U_{ni} = {} & \beta_1\, cash + \beta_2\, installment\ 10 + \beta_3\, installment\ 20 \\ & + \beta_4\, support\ for\ improved\ rice\ farming \\ & + \beta_5\, teviala\ 1\ ha + \beta_6\, Noteviala + \varepsilon_{ni} \end{aligned} \tag{2}$$

Table 2. *Covariates explaining LCM segment membership*

Variables	Description		Summary statistics	
			APT ($N = 102$)	MTD ($N = 104$)
Household-level experience	Variable indicating how long the household has been exposed to conservation restrictions.	Range Mean Std. dev	1–5 4.3 1.2	2–20 19.32 3.17
Young households	Binary variable indicating 5 or less years of household formation (highly correlated with the age of the household head) [1 = YES; 0 = NO]	YES	32 (31%)	40 (38%)
Literacy	Binary variable indicating whether the household head is literate. [0 = NO; 1 = YES]	YES	56 (55%)	82 (78%)
Tavy seeds	Numeric variable measuring the quantity of rice seed required to farm the households' swidden agriculture (*tavy*) plots, measured in *kapoaka* (a local unit of measurement, roughly equivalent to a cup). This variable is used as a proxy for the area of swidden agricultural plots.	Range Mean Std. dev Median	0–1900 208 175 201	0–1600 225 184 180
Livestock owned	Numeric variable indicating the total livestock ownership of a household measured in 'Tropical Livestock Units' (Chilonda & Otte, 2006). This variable is used as an indicator of household wealth.	Range Mean Std. dev Median	0–8.23 0.86 1.9 0.10	0–6.25 0.63 0.86 0.17
Beneficiary of World Bank project	Recent World Bank development projects in 2013 aimed at compensating households potentially affected by forest protection and encouraging pro-conservation attitudes. Each beneficiary was provided with either beekeeping, poultry or agricultural support. This variable is used as an indicator of experiences of development interventions [1 = YES; 0 = NO]	YES	17 (17%)	18 (17%)
Experiences of the improved rice farming	Binary variable indicating whether household has any experiences of the improved rice farming [1 = YES; 0 = NO] (1 = household has implemented it or seen others doing it, 0 = household has only heard about it or has neither heard nor seen it)	YES	22 (22%)	39 (37%)

The latent class model is estimated as four conditional logit models, in which the class membership probability is estimated simultaneously. The class membership probability can further be explained by possible sources of heterogeneity across segments. We included the household-level experience variable to explain segment membership as well as six relevant socio-demographic variables (Table 2).

The household-level experience variable measures how long the household has been exposed to conservation restrictions, and is calculated from two parameters:

The number of years the site has been de facto exposed to forest protection. For respondents in MTD this is 20 years as the Park was formally established in 1994. APT first received provisional protection status in 2007 but this was formalized only in October 2013 (Ruta, 2014). Penalization of two residents for *teviala* in 2009 was reported by respondents so we classified respondents in APT as having experienced 5 years of forest protection from 2009 to 2014 (but the results are not sensitive to varying this from 4 to 7 years).

The immigration status of the individual household, i.e., how long the household has resided in the area. The composite household-level experience variable takes the smaller value of any of these two variables, e.g., if the household resides in APT but has been living in the area for only 3 years, its household-level experience is 3 years whereas it equals 5 if the household has been in the area for 8 years.

Attitudinal variables in the class membership probability function may create endogeneity problems (Hess & Beharry-Borg, 2012). Attitudinal data are actually functions of latent attitudes, i.e., they are not exogenous to the choice variables and are not a genuine expression of fundamental attitudes (Provencher & Moore, 2006). We therefore estimated the ex-post individual segment membership probabilities and used this to calculate probability weighted values for these variables (Hess, Ben-Akiva, Gopinath, & Walker, 2011) using Eqn. (3):

$$X_{segment1} = \frac{\sum_{n=1}^{N} \pi . X_n}{\sum_{n=1}^{N} \pi_{n1}} \tag{3}$$

where N is the number of respondents, X is the value of the attitudinal variable, and π_{n1} is the estimated probability of respondent n falling into segment 1, computed from the segment allocation model. Data were analyzed with Nlogit 5.0 and Stata 12.

(ii) *Qualitative debriefing*

Interviews, which lasted from 30 minutes to one hour, were audio recorded after obtaining consent and professionally transcribed for theoretical thematic analysis (Braun & Clarke, 2006). We assigned codes to data segments using Nvivo 10, which were then grouped into larger themes. Codes and themes were constantly revised based on new insights from data analysis. Another co-author cross-checked the codes, the quality of the transcriptions, and checked the veracity of the translation of the extracts.

3. RESULTS

(a) *Sample characteristics*

Households across the two sites were similar in most socio-economic characteristics (Appendix E). In both sites mean household size is six and household heads averaged less than

three years of schooling. Food security is low with households having sufficient food for only half of the year on average. However there were differences in variables which may be affected by conservation restrictions: only 5% of household heads in MTD were migrants compared to 75% in APT, of which half had arrived in the last 10 years. 96% of households accessed at least one of their plots by inheritance in MTD versus 30% in APT, while only 17% accessed their lands by forest clearance in MTD versus 42% in APT. This confirms the weaker enforcement of forest protection and consequently high immigration and recent land clearance in APT. [8] The *Betsimisaraka* ethnic group forms 98% of the total sample in MTD and 80% in APT. Table 2 presents the summary statistics of the seven socio-economic variables included in the LCM as well as the household-level experience composite variable.

(b) *Latent segments and their characteristics*

The alternative specific constant (ASC) takes the value of 1 for the alternative describing the reference level (set as no cash, no support for rice farming and free *teviala)*, in all four segments, the ASC is not significant (Table 3), indicating that the full value of the proposed alternatives are captured by the attributes.

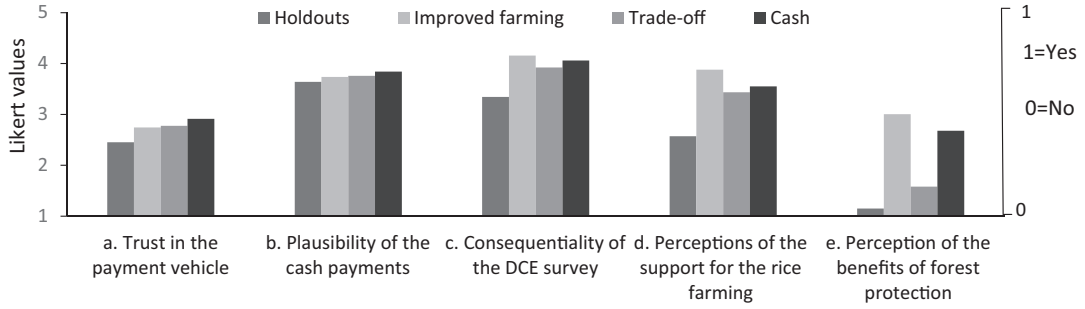
The household-level experience of forest conservation and other socio-economic variables are significantly associated with preference heterogeneity (Table 3). Segment 1 households ("holdouts", 33% of households) prefer the free *teviala* scenario regardless of compensation and are composed mostly of more experienced households who are more likely to have been left out of the World Bank funded development projects. Conversely, households in segment 2 ("improved farming", 30%) are likely to be relatively less experienced in forest use restrictions and preferred secure rights over one hectare of *teviala* to an open forest frontier. They also positively and highly value the technical and material support for improved rice farming. These households are likely to have benefited from the development project. Respondents in segment 3 ("trade-offs", 15%) are likely to be composed of households with and without experience of conservation restrictions who traded off the cash donations with use restrictions, i.e., they positively value the cash payments and get disutility from *teviala* restrictions. This segment is likely to be composed of newly formed households with young household heads. Finally, members of segment 4 ("cash", 21%) value only the cash payments (highly significant and positive), and likely comprise experienced and inexperienced households. These cash preferring respondents express a non-monotonic preference for the installment attributes, favoring the medium timeframe (10 years) to one lump sum payment and strongly disfavoring longer timeframes (20 years). Literacy rate, respondents' experiences of support for rice farming, tavy seeds and livestock owned do not significantly explain segment membership.

The follow-up data show that the majority of respondents in the four segments reported neutral views toward the independent institution which is to manage the cash donations over

Table 3. *Latent segments and their determinants. The model is estimated on the pooled dataset. For each latent segment, the coefficients show the effects on utility of changes in each attribute level on the average respondent relative to the reference level of no cash, no support for improved rice farming, and free teviala. For the installment attributes, the base level is one year*

	SEGMENT 1: "Holdouts"		SEGMENT 2 "Improved farming"		SEGMENT 3 "trade-offs"		SEGMENT 4 "cash"	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
Total cash donations	−0.112	0.180	0.068	0.098	.136**	0.071	.389**	0.214
Installment = 10 years	1.332	1.257	0.820	1.700	0.181	0.508	1.411**	0.624
Installment = 20 years	1.987**	0.892	1.138	0.821	0.592	0.516	−2.215**	0.793
Support for improved rice farming	−0.299	0.608	4.447***	1.208	0.171	0.600	−0.380	1.091
Teviala 1 ha	−3.264***	0.85	4.978***	1.141	−1.095*	0.827	−0.795	1.726
No *teviala*	−6.229**	2.748	1.118	1.851	−1.801**	1.420	−1.175	3.119
Alternative specific constant (ASC)	0.929	0.812	−2.188	1.666	−0.369	0.904	−3.446	1.259
Segment size (%)	33.3		30.2		15.4		21.1	
Explanatory variables of class probability								
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
Constant	−1.532*	0.798	1.325*	0.697	−3.153**	1.491	Fixed	
Household−level experience	.093***	0.038	−0.137***	0.050	0.038	0.061	Fixed	
Young household (1 = yes, 0 = no)	1.004	0.736	0.230	0.791	2.256**	0.899	Fixed	
Literacy (1 = literate, 0 = illiterate)	0.082	0.699	−0.242	0.656	1.040	0.985	Fixed	
Land holdings (tavy plots proxied by seeds)	0.003	0.001	0.001	0.001	.004	0.002	Fixed	
Livestock owned (tropical livestock unit)	0.041	0.015	0.035	0.030	.009	0.001	Fixed	
Experiences of the technical rice farming (1 = yes, 0 = no)	−0.556	0.570	−0.673	0.649	−0.293	0.7918	Fixed	
Beneficiary of World Bank projects (1 = yes, 0 = no)	−0.269*	0.776	1.59058*	0.917	−0.515	1.319	Fixed	
Log-likelihood	−847.067							
McFadden's pseudo R^2	0.3767							
Akaike information Criterion (AIC)	1798.134							
Akaike information Criterion (AIC)/n	1.450							
Bayesian information Criterion (BIC)	2064.35							
Obs.	1,236 (N = 206)							

Note: ***, **, * → Significance at 1%, 5%, 10% level.



a.	**Trust in payment vehicle**	"I trust that the independent institution will transparently and effectively manage the cash donation over time"
b.	**Plausibility of the cash payments**	"A donor genuinely interested in development would donate cash instead of usual development projects (e.g. improved rice farming)"
c.	**Consequentiality of the DCE survey**	"I believe that the results of this research would be used to inform policy on forest conservation"
d.	**Perceptions of the support for rice farming**	"I believe that support for improved rice farming would better my livelihoods"
e.	**Perception of the benefits of forest protection**	"Forest protection provides benefits which are important to my livelihoods"

***Statements a. b, c, d are based on a five-point Likert scale: 1='strongly disagree', 2='disagree', 3= 'neither disagree nor agree', 4='agree', 5='strongly agree', Statement e is based on a binary question (1=Yes, 0=No)**

Figure 2. *Probability weighted attitudinal variables calculated from the class membership probabilities of the latent segment model.*

time (Figure 2). They all tended to believe the cash payments to be plausible, with no large disparity between the four segments. Segment 1 "holdouts" scored the lowest for the belief in the consequentiality of the valuation exercise, as well as for the perceptions of the technical rice farming and the ecological benefits of forest protection whereas segment 2 "improved farming" believed in the consequentiality, were very optimistic toward the support for rice farming and positively valued forest protection. These patterns generally support the choice patterns of these segments.

(c) *Respondents' rationale for their choice decisions*

For each of our qualitative debriefing interviews, we assigned each interviewee ($n = 25$) to one segment based on the highest ex-post individual class membership probability from the LCM) (Appendix F). Below we highlight similarities and differences within each segment. We also describe any outliers in the "holdout" and "improved farming" segments (i.e., respondents with similar patterns of DCE responses but who differed from the rest of the segment on the household-level experience of conservation).

(d) *Segment 1 "Holdouts" (33% of the sample)*

This segment is mostly composed of more experienced households, i.e., households who have been exposed to restrictions for a relatively long period. They ($n = 7$, I1–I7—Appendix F) are not willing to trade-off *teviala* with either cash or support for rice farming.

Holdouts express rational utility maximizing arguments in favor of *teviala*: many claimed (I1, I2, I4, I5) that the crops they will be able to harvest from an open forest frontier scenario and the utility they would thereby expect far outweigh the cash payments offered. They believe that *teviala* is sustainable and can continue across many generations, they are confident that they will be able to produce the highest and most reliable yields from forest lands given the expertise they have acquired over centuries of trial and error. They do not value cash payments due to their limited opportunity to invest them (such as remoteness and lack of market access).

Some (I5 to I7) also emphasized the important cultural values of *teviala* practices, how they make a living is deeply rooted in their cultural norms and they find it hard to imagine alternative ways of life. They also talked of the importance of compliance with *tavy* rituals and submission to traditional authorities (*tangalamena)* with regard to access to new lands.

Holdouts also anchored their choices on concerns for their future descendants' needs. Land from *teviala* is seen as the most valuable inheritance they can leave their children and they considered accepting cash as a self-centered behavior, betraying their future descendants' rights and needs:

> "So supposedly, we will receive cash for 10, 20 years, and that's it? Then what are we supposed to do since we cannot do *teviala* anymore, what would happen to my children and my grandchildren? Let it be very clear, if cash payments will flow every year, forever, just as people who worked for the government (*fonctionaire*) are still receiving retirement pension, then we would be in, otherwise, no."
>
> [I6 (indigene, 58, MTD)]

This segment also expressed concern that only the elites and the socially well-connected households would benefit from external help, leading to suffering by the most vulnerable groups often most affected by restrictions on land uses. Interestingly, this group does not recognize any ecological benefits from the forests. These perceptions were not altered by further probing about examples of regulating services such as climate regulation, erosion control, and cleaner air.

Many interviewees in this segment (I3 to I7) were distrustful of the proposed novel agricultural technique which they

believe is not suited to the conditions under which they farm as exemplified by the statement: "rice cannot be grown without fire, you simply can't." (I7, indigene, 37, MTD). They have been disappointed by the training provided and the lack of follow up provided by similar interventions in the past and claimed that these new techniques require substantial start-up funds and support that external agents failed to deliver. This contradicts the LCM results which suggest that the experience of support for improved rice cultivation does not significantly explain the grouping identified. [9]

Two outliers (I1 and I2) exhibited the same choice patterns as segment 1 but are young households in APT, recent migrants and hence lacking long experience of use restrictions. They share the concerns of the rest of the segment over land scarcity but for these outliers, choices are principally driven by land scarcity caused by the rapid immigration and high level of conflict over access to land rather than experience of forest use restrictions. As I2 (migrant, 22, APT) said:

> ``I came too late, there are no unowned forests left nearby, we have to borrow fallow lands which are not very fertile. As I recently got married, I haven't got my share, I have to acquire my own lands to feed my family, but I do not dare clear forests as they all have owners."

(i) *Segment 2 "improved farming" (30%)*

These households have been exposed to forest use restrictions for a relatively short period. They ($n = 10$, I8–I17) positively prefer a one-off, one hectare, legal forest clearance permit to strict protection and unanimously associate this with secure individual land tenure, which they value highly. Since competition for new forestlands is becoming increasingly fierce where forest protection is weakly enforced, the longer established households or indigenes among this group believe that legal forest tenure would better enable them to establish claims over forestlands. They fear losing their forest and fallow lands to the ongoing influx of migrant smallholders. They despise the military enforcement of strict forest protection and argue that they are in a much better position to protect their forests than any state representatives as long as they have legal tenure.

Many of this segment claim that they do not intend to clear the one hectare of forestlands but preserve it for their descendants who can clear it if they do not have better options.

> ``The way we perceive things now, our children may perceive it differently, they may no longer want to protect these forests. I think this will depend on their education and whatever alternative livelihoods they find. For instance, if they get some education, they may find other options, who knows, they may decide to move to town. Otherwise, they may just clear these forests. Only fate will decide..."
>
> [I12 (indigene, 20, APT)]

These households also highly favor the support for improved rice farming, although their experiences of such agricultural interventions are generally low. These respondents, especially migrants, often associate the proposed improved rice farming with paddy fields and digging, a practice they are familiar with. Indigenes are also willing to try the approach but feel the topography with few exploitable valleys constrains the likely success. Nonetheless, they perceive the technical and material support for agricultural intensification as more dependable than cash.

This group also slightly preferred the strict forest protection attribute to an open forest frontier (although this is not statistically significant). Perceived societal benefits of forest conservation (positive externalities including ecological services) contribute to these preferences, as well as the fear of losing land to the ongoing influx of migrants.

Like the 'holdout' group, this group tends not to value cash payments highly due to their perception of the limited opportunities to invest cash ($n = 10$). Some (I9, I16, and I17) mentioned they would prefer communal investment (such as improved market access through road construction or health centers). One respondent (I9) associated the cash donations with credit which he perceived as extremely damaging and prone to hidden agendas, noting that nothing is ever free.

Just as for the holdouts, two outliers differ from others assigned to this latent class (I16 and I17) as they have experienced at least 20 years of strict forest protection. Their main rationales do not significantly diverge from the majority in this "improved farming" segment as they view forest protection as something that their future descendants and the world should benefit from. The one hectare of *teviala* permit is perceived as a shrinkage of the national park, and recognition of people's needs, i.e., they aspire to a secure right to clear that they would not necessarily exercise.

(ii) *Segment 3 "Trade-off" (15%)*

Segment 3 "trade-off" is composed of both experienced and inexperienced households. These households ($n = 3$, I18–I20) seem to have traded off the cash donations with use restrictions, i.e., they are willing to accept cash compensations to offset the foregone benefits of future forest use restrictions.

The less experienced household head interviewed in this group (I18) shows explicit economic reasoning, trading-off the amount of cash with the revenue he would get from forest clearing. He also clearly differed from the previous two segments in the value he gave to cash payments and can envisage investing cash to generate returns. A recent immigrant from the *Merina* ethnic group (from the generally more developed region around the capital), ascribed his ability to invest money to his previous experience of urban life and his alternative sources of income (his wife is a government teacher). This household head does not intend to do *teviala* at present but would be attracted by the opportunities to clear forests should the forest frontier be open.

> ``If forest frontier is open, anyone, whether the wealthy or the poor, those who have got lots of lands and those who are deprived will go there and farm in the forest, to be honest, even me, we must do *teviala* if restriction is lifted, since there is no longer any obstacle."
>
> [I18 (recent migrant, 42, MTD)]

The more experienced respondents in this segment (I19 and I20) on the other hand recognized the value of cash compensation and insisted that such compensation was a right. Just as the state and the society have the right to benefit from forest protection, they believe that they should be also entitled to sufficient compensations.

> Since they don't even allows us to farm on the fallow lands that our ancestors left for us, they must compensate us. Otherwise, we will forcefully enter the park, we will fight for our rights, it is a sacrifice that I am ready to make for the next generation. We are actually entitled to get 50% of the park tourism revenue, but that's obviously not enough! This money was not even enough for the school construction. 50% of the park tourism revenue is not enough for four *Fokontany*. Receiving money as compensation for forest protection is fine but small amounts of money don't make sense."
>
> [I19 (indigene, 39, MTD)]

Respondents assigned to this class are likely to be younger households (Table 3). Despite their willingness to trade-off rights to *teviala* with cash, some of them raised concerns about ongoing need for land.

> ``I am willing to accept cash donations since I won't be able to do *teviala* anymore, but money alone is not enough because it is very difficult to use it here, particularly if you don't have lands that you can cultivate. So ideally,

we should get both new lands and money so that we can invest the money in our cultivation."

[I20 (indigene, 24, MTD)]

Households in this segment generally express neutral preferences for the improved rice farming. They prefer cash that they can use as they wish over externally defined development projects.

(iii) *Segment 4 "Cash" (21%)*

Respondents belonging to this class get a highly positive utility from the cash payments and seem indifferent to any forms of forest use restrictions and improved rice farming. They comprise both experienced and inexperienced households ($n = 5$, I21–I25).

Some households (I21 and I23) are not interested in *teviala* at all—they associate *teviala* practices with an undesirable nomadic lifestyle. Others (I22, I24, and I25) emphasize that if they had alternative livelihoods, they would happily abandon *teviala*. Some have already started seeking alternative agricultural techniques to adapt to forest use restrictions e.g., by converting small valleys to paddy fields. They believe that paddy fields will last and be transferable to future descendants whereas clearable forests will not be available forever.

Households in this segment are eager to intensify agriculture on paddy fields. They often see paddy fields and improved (rain fed) rice farming as two conflicting practices that cannot go hand in hand given their limited resources and capital. They are relatively uncertain about the prospective yields from the improved rice farming and will only adopt if demonstration projects are successful:

``They need to implement pilot projects first, if they are successful, people will be automatically in, long speeches are useless, people just want to see for themselves."

[I25 (indigene, 64, MTD)]

This segment highly values cash which they currently feel constrained by: "Like a foreigner trapped in one island, our hearts are longing for so many things but we cannot find dry land to move over" (I25). Cash compensation would enable them to afford to send their children to the nearest town, to pay their school fees and living costs. One young household head, I23, (21 years old, recent migrant, MDT) expressed his intention to migrate to urban areas and open a small shop.

The utility that these households expect to get from the installment attribute is non-monotonic i.e., when compared to a lump sum payment, they strongly prefer a 10-year time horizon but highly disfavor the long time horizon (20 years), other things equal. They ascribe the preference for the 10-year timeframe to their inability to invest money and the volatility of cash. The 20-year timeframe is however perceived as less trustworthy.

Responses suggest that this group did not consider any societal values in their choice decisions but were instead mostly concerned about their households' well-being:

``If I disclose my choice to others, they won't be happy with me, but I do not care and anyway, you assured me that my answers will be kept secret, as the saying goes: Roosters fighting in the tomb, both strive to stay alive."

[I23 (recent migrant, 21, MDT)]

(e) *Are the theoretical assumptions of the DCE method met?*

The qualitative debriefings suggest mixed evidence on the continuity axiom which requires that respondents should attend to all attribute levels across each of the alternatives and trade them off while evaluating their preferred choices. In many cases, we find a no (or low)-value of the attribute rather than a non-attendance (or total ignorance), albeit violation of the continuity axiom did happen in a few cases.

There are for instance some cases (e.g., I1, I2, I4, I5 in segment "holdouts") where, although the choices made suggest respondents were fixating on a single attribute rather than attending to all attributes (known as lexicographic preferences), the information provided in the qualitative debriefings shows their decision-making processes were consistent with the continuity axiom. They did attend to the cash attribute and weighed up the values of teviala against the cash payments. Likewise, I10 and I11 (assigned to the "improved farming" segment) reported that they compared the cash payments with the utility they would get from legal forest tenure. Trade-off is most explicit among segment 3, as I18 stated:

``So let's see, if I receive a payment of nine million Ariary over 10 years, which amounts to nine hundred thousand Ariary per year, and even if I still continue farming here, that won't be profitable. But then if it goes up a little bit, to let's say 12 or 15 million, then it may be more attractive. If I get for instance 12 million just as a lump sum payment, that would be really ideal, that would definitely be my preferred choice. ... If I get 15 million, I will build a house in town, then I will rent it out, I can still continue living here, so that I can get a monthly revenue on top of my crop revenues. If I receive the payments over let's say 20 years instead of a lump sum, I will then invest part of it in some lucrative activities like poultry, and then keep some in the bank, so by the end of 20 years, I will have saved large sums of money."

[I18 (recent migrant, 39, MTD)]

Similarly, respondents' accounts suggest that instead of exhibiting lexicographic preferences, they rather expect lower utility from other attributes. Holdouts (segment 1) claimed for instance to have considered the cash donations but simply do not value cash given its limited value in the context in which they live. As I3 attested:

``If we were sure that the cash would really cover all our needs and if we were confident that investing it would generate returns and be profitable, we might have liked it, but the reality is quite different."

[I3 (indigene, 47, MTD)]

A few interviewees, however, admitted overtly to having not attended to some attributes. For instance, I6 and I7 (holdouts) clearly expressed that they ignored the cash payments not because the utility levels of the cash are low or zero (as their choices might imply) but because they do not believe that the cash payment would really happen in reality. Their accounts suggest feelings of disappointment toward external agencies promoting alternative livelihoods or implementing compensation measures, for instance they claim to have not perceived any benefit from the park's establishment but instead have experienced destitution. They (I5, I6, I7) also anchored their choices on the incommensurable cultural value of *teviala* by stating "nothing will ever compensate us for *teviala*, it is our identity".

Similarly, some segment 4 households ("cash") did not consider the *teviala* attribute at all in their choice decisions. For instance, I23 is only concerned about how he can best invest the cash to generate returns. I22 and I24 pointed to the very small likelihood of an open forest frontier; "Forests are already well protected, the government is very determined to protect it". However, they also genuinely favor forest protection and would like their future descendants to enjoy the forests' multiple benefits; "I want my children to have real-life experience of lemurs' songs, I do not want them to become an ancient history that they would only hear on the radio once all the forests are gone."

We however find that experience of forest conservation or compensatory interventions are not systematically associated

with violations of the continuity axiom. Instead, respondents' thought processes suggest that apparent non-conformity to the continuity axiom does not imply invalidity of respondents' choices, i.e., they represent their genuine preferences. For instance, if most *holdouts* and *improved farming* households do not attend to cash, it is because they genuinely attach a low importance to that attribute.

With regard to the content validity of our DCE survey, i.e., the extent to which respondents found the payment vehicle plausible or believed in the consequentiality of their choices, the qualitative debriefings suggest that most of the interviewees' choices ($n = 19$ out of 25, 76%) conform to the assumptions of the method. Although a few interviewees (I5, I6, I7) explicitly raised issues with regard to the plausibility of the cash payment scenario (e.g., "Getting that much money or any aid at all from faraway donors is utopia") or the survey scenario (I22 and I24), the majority of respondents did perceive their choices as consequential and were actively engaged with the DCE survey. Most respondents were also pleased to be consulted about their preferences and aspirations. As I25 asserted:

> ``The choices were so appealing, we thoroughly enjoyed participating in the exercise, it is the first time that a researcher asked us about what we really need and want.
>
> [I25 (indigene, 64, MTD)]

4. DISCUSSION

(a) *The effect of experience of forest use restrictions and compensatory interventions on welfare impacts of forest conservation*

Our results suggest that household prior experience with forest use restrictions has a strong influence on both their appraisal of the welfare impacts of future restrictions and expectations of compensatory mechanisms. Our results therefore suggest caution is needed in using DCE as a means of estimating compensations for long term and complex projects such as forest conservation. Although two segments (trade-off and cash—36% of the total sample) are composed of both experienced and inexperienced households, their rationales substantially differ and are anchored in their experience of forest use restrictions. Our results are consistent with previous studies which show that experience with a good or policy markedly influences both WTP estimates and the predictability of respondents' preferences (e.g., Adamowicz, 1994; Ferrini & Scarpa, 2007; Hanley, Kristrom, & Shogren, 2009).

Our findings could be considered evidence of experiential learning (Kolb, 1984). Experienced households gave many accounts of why they value their rights to continue *teviala* practices owing to a solid knowledge of the no *teviala* policy in question and their negative experiences of development interventions. Their lack of interest toward the improved rice farming is consistent with the high failure rate of such interventions. A number of studies (e.g., McConnell, 2002; Pollini, 2009; Scott, 1998) have described how agricultural development interventions are often not taken up due to requiring unrealistic labor inputs and because farmers cannot afford to invest in something unproven. While one can conclude that they may be biased against novel alternatives, we argue that their preferences are the outcomes of learning and knowledge gained through adaptive processes (Denrell & March, 2001).

The high value attached to *teviala* by experienced households is consistent with anthropologists' findings in Madagascar that deforestation is often driven by a desire to attain customary tenure, since agricultural land is usually private, while forest land often is not (Keller, 2008). The high cultural value of *teviala* to *Betsimisarika* farmers is also important (Desbureaux & Brimont, 2015; Hume, 2006). The reason why many respondents treat cash as dubious and unreliable is supported by Sandel (2000). That is, their indifference toward the cash is anchored in the very reasons why it is useful, i.e., it is anonymous, easily transported, and easily spent. They viewed agricultural lands accessed by forest clearance as a long-term land acquisition strategy which is not as easily substitutable or interchangeable with other goods or assets as cash with its fleeting nature. The strong bequest value of *teviala* practices, i.e., the value they placed on ensuring higher utility for the future generation from forest clearing may explain the highly positive utility of the 20-years' time horizon (Table 3). Forest clearing is viewed over a long-term planning horizon, not to address the immediate households' needs but those of future descendants. Such findings challenge the pervading myth that indigenous communities have a high discount rate or high time preference rate (e.g., Holden, Shiferaw, & Wik, 1998; Poulos & Whittington, 2000).

In contrast, households with limited experience of forest conservation exhibit substantially less aversion to losing their rights to continue *teviala* than more experienced respondents. This is in stark contrast to the "endowment effect" theory (Thaler, 1980) which predicts that an individual values a good more highly if his/her rights toward the good have been established (*de facto or de jure*). Psychological feelings that can be interpreted as regret (Loomes & Sugden, 1982) may explain this result, i.e., more experienced households regret losing the previous open forest frontier that they used to benefit from and anticipate regret in relation to the continuation of tightened forest protection.

Respondents who are inexperienced in terms of exposure to conservation restrictions ("improved farming" segment), have also been affected by their experience of open access, and their strong preferences for the legal forest tenure may originate from their inability to exclude others (Ostrom, 1999). In APT there has been very rapid recent immigration of people from a variety of ethnicities (*Merina*, *Betsimisaraka* and *Bezanozano*) attracted by land availability. These inexperienced households' strong preference for the improved rice farming is consistent with the positive correlation between individual land tenure and adoption of more efficient land management practices reported by previous scholars (e.g., Barrows & Roth, 1990). This is also supported by some respondents, who although indigenous, appear more inclined to adopt new techniques only after they have freely benefited from an open access situation and realized that forests are becoming increasingly scarce. Thus it is not just experience of the interventions that matters, but experience of relevant counterfactuals. *Ex ante* estimates of compensation based on DCE might therefore benefit from deliberately including respondents with a variety of experiences.

(b) *Theoretical and content validity of DCE results*

Although we found violations of the continuity axiom among six debriefed respondents, most gave accounts of decision-making processes which conform to the axiom. Our qualitative findings suggest that most apparent patterns of attribute non-attendance are in fact theoretically valid, i.e., genuinely represent respondents' anticipated welfare impacts. Excluding these responses would bias the DCE outcomes and resulting policy implications (Lancsar & Louviere, 2006).

Other studies using focus group debriefings of stated preference techniques (Clark, Burgess, & Harrison, 2000; Powe *et al.*, 2005) or verbal protocol analyses (Schkade & Payne, 1994) (all in developed country settings) found that many respondents' willingness-to-pay figures are not consistent with rational choice theory and instead represent resistance to the commodification of nature. While it is clear that these values do not reflect the worth of the good being valued, Clark *et al.* (2000) argue that they are rational preferences and should still be considered "economic", as the definition and importance placed on rationality depends on the approach to consumer theory to which one ascribes.

We concur with Hess *et al.* (2013) and Balcombe, Fraser, and McSorley (2015)'s conclusions which call for the reappraisal of previous DCE studies showing or inferring significant shares of attribute non-attendance and using alternative modeling approaches to accommodate this issue. In our study context, although the insignificance of the cash among the "holdouts" and "improved farming" segments poses significant complications for the computation of monetary willingness-to-accept estimates, they accurately represent how respondents believe that forest protection will affect local livelihoods. Our findings, together with previous literature (e.g., Hensher, 2010b), suggest that DCE researchers may need to re-engage with the psychology of decision making and look more into processes, i.e., how respondents construct their choices and what constitute actual violations of the assumptions of rational choice theory. As Gregory and Slovic (1997, p. 3) put it, "*truth may ultimately reside in the process of the evaluation, rather than the outcome*" and DCE researchers can gain deeper understanding of respondents' thought processes using qualitative methods.

The satisfactorily high content validity of our results can be mostly attributed to the considerable efforts we put into piloting the valuation survey and explaining it to respondents. We used large photographs and dolls to represent the donor and gendarmes and colorful background papers to represent the three alternatives in each choice set. We also used lengthy warm-up steps before giving the actual choice sets to give respondents some practice. The warm-ups also helped establish trust with the enumerators, desensitize forest clearance and ensure that respondents understood the task of making trade-offs. This approach was successful for ensuring the respondents understood the aim of the task and that it was hypothetical (important for ethical reasons; see Appendices A and B). In our case the interview necessarily lasted on average an hour and a half, this, and the time needed to reach households, should be borne in mind by researchers hoping to achieve large sample sizes.

(c) *Study design*

It is important to note that our research design means it is not possible to isolate completely the effect of experience on the welfare impacts of forest conservation. The inferences we can draw from the results must therefore be read in terms of this important caveat. Randomizing an intervention (such as exposure to forest use restrictions and compensatory projects) or collecting longitudinal data with unambiguous baseline measures from recently established protected areas would enable isolation of potential confounding variables, such as households' immigration status, but would be impractical and would raise ethical concerns as they may involve long-lasting negative effects.

There is always a compromise between the external validity of a natural experiment, and the ability to isolate the effects of a specific variable (in this case experience of conservation on respondents' preferences). In real world settings, it is often not possible to eliminate all rival explanations (e.g., in our case, immigration may not be exogenous to conservation restrictions). Our quasi-experimental approach comparing communities differing in their experience of forest use restrictions matched on important socio-economic parameters is the only practical option in these circumstances. The use of a real-life setting, with all the relevant context, has value in its own right and increases the applicability of our results to other development interventions, despite not allowing perfect and unambiguous attribution. In addition, the qualitative debriefings provide evidence that corroborates the effect of conservation experience. The holdout households' experience of conservation restrictions and compensatory interventions have motivated the very low value that they placed on improved agricultural techniques as well as the long-term importance of lands accessed by forest clearance that far outweighed the proposed cash compensations. On the other hand, the "improved farming" households who have experienced weaker and less consistent enforcement dreaded a tragedy of the commons situation and were averse to an open forest frontier scenario or weak protection.

Despite the limitations of our experimental design, our study offers some important practical recommendations for designing DCE surveys in remote and impoverished areas of developing countries where literacy rates are very low and the good being valued is sensitive (see Appendix A). Finding the right balance between managing expectations and ensuring workable and realistic scenarios requires careful adjustments as well as extensive piloting, ideally interspersed across sequential stages. A balance must also be struck between emphasizing the neutrality of the research and ensuring the credibility of the scenarios, particularly that of the institutional regime which would deliver the hypothetical good. Crafting the right language for the valuation scenarios warrants careful consideration and often encompasses nuance that is lost in translation. If the research is led by foreign researchers, involving local researchers who understand the cultural norms and the language in the design and piloting, at the early stages of the survey design is therefore critically important.

(d) *Policy implications*

There have been a number of commitments stating that local people living at the forest frontier, many of whom are extremely poor and marginalized, should not be negatively affected by efforts to conserve forests for the global benefits they provide (Martin, McGuire, & Sullivan, 2013). Estimating how much or what type of compensation is appropriate is challenging as those with experience of forest use restrictions provided very different appraisals of the local welfare impacts of future conservation restrictions than those who lack such experience. Thus, although we find encouraging evidence that DCEs can be successfully used in a rural developing country context with low literacy to elicit current preferences (high theoretical and content validity of the DCE survey), *ex ante* valuations of welfare impacts of conservation may not accurately estimate compensations necessary for forest use restrictions. When respondents are more experienced with forest protection, neither cash nor support for an improved rice project is perceived to compensate them for *teviala* restrictions.

The high level of confounding between households' immigration status and their experience of conservation restrictions however implies that "experience" is not a simple parameter. While the "holdouts" segment households have more experi-

ence of strict protection, the "improved farming" households have also experience of weak protection and the resulting immigration. The two segments have therefore differently informed preferences and any single population of respondents may never have experience of both scenarios. Researchers should therefore aim to elicit preferences from individuals with different perspectives (not just the population that will be affected, but also populations that have been affected) when doing *ex ante* evaluation, and use these different preferences to model the local welfare impacts of a given intervention.

Nevertheless, considerable difficulty will remain when using DCE to accurately estimate, in advance, the appropriate compensation for a conservation intervention that may affect people negatively. This calls into question the viability of the model of equitable coercive conservation.[10] We argue that there is a need to rethink conservation approaches, particularly the urgency which with interventions are implemented and the feasibility of achieving fair compensation for coercive measures.

The strong bequest motive for maintaining the rights to clear land among experienced and inexperienced respondents alike suggests that secure forest tenure may slow down deforestation. Many households valued secure tenure because it would allow them to retain the option of accessing new agricultural land in the future, without having to clear it now, to avoid losing it either to the state or immigrants. This is a well-known result in fisheries economics, where harvesting is higher in open access fisheries and slows down when fishers are granted individual property rights (Holzer, 2015). Many have argued similarly that promoting legal titles to land in forested areas with weak property rights can be similarly effective (e.g., Chhatre, Lakhanpal, Larson, Nelson, Ojha, & Rao, 2012). While giving secure common tenure over forests to stable communities (i.e., with a tradition of communal and shared ownership) might slow deforestation without any ban on *teviala*, individual legal tenure may be prioritized when the situation is not an idealized village with clearly defined common rights. Either way, conservation could then be negotiated through PES schemes where local people's participation is genuinely voluntary. This could take the form of renewable easements, to allow local residents to learn over multiple transactions. This recommendation is driven not only by a concern for social justice and equity (Hellum & Derman, 2004), but also by a pragmatic assessment that local forest dwellers have the greatest impact on resources and also the most to lose from non-sustainable uses of these resources. When *ex ante* estimates of compensation are very difficult to achieve, voluntary PES schemes may actually have lower transaction costs relative to trying to achieve fair compensations if markets are competitive and property rights enforceable (Pagiola, Arcenas, & Platais, 2005). However, formalizing individual ownership may be open to elite capture and embed inequalities. We argue, however, that any mechanisms aiming at achieving equitable compensations would likely face the same constraints.

Where conservation is imposed on local people, and forest tenure remains with the government, great care needs to be taken in developing approaches to adequately compensate for welfare impacts of conservation restrictions. We argue that the welfare impacts of forest use restrictions must be continually monitored. Otherwise local livelihoods may be seriously harmed. Compensation using cash, while a preferred option for some households, has significant limitations because of the limited opportunities for investment in remote rural areas, and lump sum payments are most problematic. Those most likely to be affected negatively by conservation restrictions may be least able to invest cash to generate returns. However, the reluctance of some groups to engage in improved agricultural techniques, and the very low values they place on such interventions, should also suggest caution when providing development projects as compensation schemes. Such schemes need to promote development interventions which will both be effective in the region but also accepted locally.

NOTES

1. *Ex ante* assessment methods predict the impact of a program or policy prior to their implementation (Todd & Wolpin, 2008).

2. Choice experiments and contingent valuation methods are stated preference techniques which are a set of valuation methods which allow analysts to generate welfare estimates of environmental benefits/damages based on respondents' stated willingness-to-pay or willingness-to-accept estimates. (See Freeman (2003) for an introduction to SP techniques in environmental valuation.)

3. In this study, we define validity as a property of a method *given* a particular intended application of that method. Thus a certain DCE may be valid if the objective is to reveal people's current preferences, but the same DCE may be invalid if the intention is to use it to decide how much respondents must be paid in compensation (or what type of compensations) so that they are left no worse off.

4. In economics, these compensations are termed "compensating variation" which is the amount of money needed to render a person indifferent to a policy change that would make them worse-off (e.g., price increase or quantity decrease), i.e., it measures the amount of money required to maintain a person's economic welfare, at the level it was at before the change (Freeman, 2003).

5. The smallest administrative unit in Madagascar.

6. of which 102 households were randomly allocated to the choice experiment survey used in this study.

7. For comparative purposes, we also estimated a conditional logit model and a mixed logit model where the cash attribute is interacted with the household-level experience variable (see Appendix G).

8. We did not include these agricultural practices (see Appendix E) in the LCM as they are mechanisms that are in the causal pathway (conservation restrictions affected how local people accessed lands and practiced agriculture). The inclusion of the household-level experience variable should have already accounted for their potential effects on respondents' preferences.

9. The experiences of the improved rice farming variable is insignificant in all four segments, i.e., the four segments identified by the LCM are not significantly different with regard to their experiences of the improved rice farming.

10. The term "coercive conservation" refers to conservation measures that are imposed by the state on local communities, and are backed by state enforcement. Such repressive models of conservation often lack local legitimacy, local participation is not voluntary, and compliance is obtained by coercion either by the use of military forces or other law enforcement agencies. The term was used in Peluso's (1993) influential

article which characterizes tropical developing states' strategy to appropriate control over productive forest resources despite local resistance.

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APPENDIX A. SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.worlddev.2017.02.009.